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THE INFLUENCE OF LOCALITY, SEASON, AND TIME OF DAY ON VISIBILITY DISTANCE

An office report

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During the past few years eastern national forests, national parks, and other forest fire protection agencies have been preparing detection plans which show the number and location of lookout points needed for the most efficient coverage of their protected lands. Ordinarily in detection planning each prospective lookout station must compete with every other one for a place in the final network. Relative values of potential observation points are determined from the amount and character of area visible from each point for normal or average visibility distance.1/

Detection plans have been weak in one respect because normal visibility distance heretofore had to be estimated. Usually a normal range of visibility was adopted for a group of forests because the difference in normal visibility distance from one forest to another was unknown. Detection plans could be strengthened if the magnitude of these local differences in normal visibility distance were determined.

Current haze meter measurements of visibility distance provide the basis for day-to-day shifts in the number of lookout stations manned as the haziness of the atmosphere changes but an analysis of several years' records is necessary to show consistent sectional differences, and diurnal trends in the range of visibility. Knowledge of such sectional and seasonal differences is needed in detection planning because it shows what the normal strength of the detection force must be on each forest for each season of the year. Diurnal changes in visibility must be known to guide the scheduling of haze meter readings.

Variations in Visibility Distance

Realizing that ultimate improvement and refinement of detection plans will require information on variations in normal visibility distance, the Appalachian Forest Experiment Station and the Eastern Region of the Forest Service have cooperated in a study of visibility.2/ Approximately 50 national forest lookout stations measured visibility distance three times a day in the four cardinal directions from 1936

1/Visibility distance is the maximum number of miles that lookout observers can distinguish a standard size of smoke column under specified atmospheric conditions.

2/This study was initiated by C A Abell, formerly of the Appalachian Station, and D. W. Beck, of the Eastern Region.

through 1938, these data forming the basis for this report.

About 21,000 observations3/ were compiled to show what differences could be expected in normal visibility distance among five eastern national forests; namely, the Cumberland in Kentucky, the George Washington and Jefferson in Virginia, the Monongahela in West Virginia, and the White Mountain in New Hampshire. Additional data for other forests were not sufficiently adequate to summarize.

In all compilations zero visibilities caused by rain or fog were eliminated. Blanks in records were usually due to the fact that lookout stations were not manned in wet weather. Thus, the average visibilities and all other figures reported here actually apply to periods of fire-weather only.

Tables are available to convert haze meter readings to visibility distances for any size of smoke column. The haze meters themselves are calibrated on the basis of a standard-sized smoke, approximately equivalent in volume and density to the smoke produced by a 12-by-12-foot fire burning in light fuel, such as grass and leaves, on an average dry day.

In the eastern United States where light fuels predominate, the initial spread of fires is so rapid that they usually attain a much larger size than 12-by-12-feet within the 15-minute discovery time standard. It has been found that visibility distances in terms of eighth-acre smokes are a more satisfactory basis for detection planning.4/ Hence, compilations of visibility distance have been made for this size of smoke column. The standard 12-by-12-foot smoke is so widely used throughout other regions, however, that visibilities have been determined for this size column, as well, for comparative purposes. Figures 1 to 5 indicate that eighth-acre smokes, which have about six times the diameter of the standard smoke, can be seen approximately twice as far 100 percent of the time and one and one-half times as far 70 percent of the time.

The following three types of compilations have been made for each

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3/An "observation" is an average of four haze meter readings taken in the cardinal directions.

4/See Technical Note No. 28, "Relation of Byram haze meter readings to safe visibility distance of smoke from an eighth-acre fire", by George M. Jemison, February 2, 1938, Appalachian Forest Experiment Station, Asheville, N. C.

forest on the basis of eighth-acre and standard 12-by-12-foot smokes: (1) the percentages of time that visibility distances equal 1, 2, 3, - up to the maximum number of miles for each month, (2) the average number of miles that smoke columns can be seen 70 percent of the time[5] for each year and month, and three different hours of the day, (3) the percent of time that visibility distance equals six miles by years, months, and time of day. Tables 1 to 30, which accompany this report, give these detailed figures for the five national forests.

Sectional Variation

Significant differences in normal visibility distance from one forest to another, summarized in Figure 6, may be explained largely on the basis of population density and industrial activity on or adjacent to the national forests because homes and factories are responsible for most of the smoke in the atmosphere. The Cumberland National Forest, with visibility distances but half of those on the White Mountain, has hundreds of people living within or near its boundaries. Large towns and industrial centers lie to the north and west, the directions from which prevailing winds blow. The White Mountain National Forest, on the other hand, largely lies in a thinly-populated and non-industrial section of New Hampshire. The clear masses of polar air that move across Canada from the north and west have picked up but little smoke and dust by the time they reach the White Mountains. Figures 1 to 5 further emphasize the sectional difference in visibility distance. A standard smoke can be seen six miles 79, 74, 56, 43, and 26 percent of the time, on the White Mountain, Jefferson, George Washington, Monongahela, and Cumberland National Forest, respectively.

Seasonal Variation

The influence of season on visibility distance is significant but can best be allowed for on a day-to-day basis because of the extremely variable nature of the events that cause seasonal differences. For example, on the Monongahela National Forest, November, 1936, had the lowest visibility average ever recorded for a single month. However, in November, 1938, the visibility distance approached the highest averages ever reached. The low visibility of 1936 was due to a preponderance of local fires.

Only on the White Mountain National Forest are seasonal variations of a magnitude that warrants consideration in detection planning.

5/The distance that smoke columns can be seen 70 percent of the time is a detection planning standard recommended for eastern forests. See "Planning a lookout system", by C A. Abell and R. M. Beeman, May, 1937, Appalachian Forest Experiment Station, Asheville, N. C.

Here visibility distance 70 percent of the time ranges from 13.4 miles in June to 8.7 miles in August. Thus, from the standpoint of normal range of vision, more lookout observers should be planned for during the latter month.

As shown by Figures 7 and 8, visibility distance is low on all forests in the summer when atmospheric dust is most prevalent and in winter when local smokiness increases. It is highest in late spring and early fall.

Diurnal Variation

Visibility distance definitely varies from morning to night but the changes are too small to require consideration in detection planning. Visibility is lowest in the morning, greatest at noon, and slightly lower at 4 p.m. Thus, visibility is actually higher, during the part of the day when fire danger is the greatest, than is indicated by a morning haze meter reading. The differences in visibility distance approximate one mile and are relatively consistent throughout the year as shown in Figures 9 and 10.

Summary

Measured visibility distance, in addition to guiding day-to-day placement of lookout men, provides the basis necessary to strengthen detection plans which have heretofore failed to allow for normal differences in visibility distance from one forest to another.

Observations at 50 lookout points, 1936 to 1938, show that significant sectional variations in normal visibility distance exist among eastern national forests. Seasonal and diurnal changes in visibility are smaller and can best be allowed for on a day-to-day basis.

TABLE 1.

PERCENT OF TIME EIGHTH-ACRE SMOKE IS VISIBLE ON THE CUMBERLAND NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	All months
	Percent of time visible												
1	100	100	100	100	100	100	100	100	100	100	100	100	100.0
2	92.1	97.3	96.9	98.7	99.1	99.6	99.4	98.8	99.2	92.3	96.0	95.7	97.1
3	84.3	92.6	86.7	93.7	96.8	96.2	94.9	96.7	97.8	87.2	83.3	84.0	90.7
4	70.6	82.7	75.8	86.5	93.5	91.0	84.2	92.1	95.7	81.2	67.9	69.3	81.7
5	63.8	76.0	68.8	78.5	90.0	86.8	71.5	89.7	93.2	75.6	57.4	58.0	74.9
6	50.1	62.4	54.1	65.8	79.5	77.2	58.2	77.3	87.5	66.2	40.8	41.0	62.1
7	39.6	51.4	40.8	55.1	69.1	65.2	39.9	66.6	77.3	57.7	29.4	30.5	50.9
8	26.3	36.3	25.2	39.6	53.1	51.2	23.4	50.3	62.1	42.7	20.1	17.6	36.7
9	15.7	22.1	11.2	27.0	37.2	36.0	10.1	38.5	50.6	31.6	12.2	9.8	24.7
10	9.6	12.8	5.1	15.7	19.5	21.7	0.6	19.9	32.8	20.5	6.8	5.4	14.0
11	6.2	8.8	3.6	11.9	12.0	14.5		13.1	24.4	14.5	5.1	3.7	9.7
12	1.5	4.2	1.9	6.8	4.5	7.5		8.4	13.5	8.1	2.4	2.8	5.0
13	0.3	0.6	0.9	4.6	1.5	3.2		4.9	2.9	4.7	1.5	1.5	2.4
14		0.1	0.3	3.5	1.0	1.5		2.3	2.9	2.1	1.1	0.9	1.3
15				1.6		0.6		0.5	1.4		0.2	0.3	0.5
16				0.9				0.2	0.2	1.3			0.2
17													0.1
18				0.1	0.1					0.4		0.2	0.1
Visibility Distance: 70% of time, miles	4.1	5.4	4.8	5.7	6.9	6.6	5.1	6.7	7.5	5.6	3.9	4.0	5.4
Basis, number of observations	585	625	686	681	682	469	158	572	512	234	826	652	6,682

TABLE 2.

VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE ON CUMBERLAND NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 6,682 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.		12:00 noon		4:00 P. M.	
	1936	1937	1936	1937	1936	1937
January		3.9		4.9		3.9
February		4.8		5.8		5.6
March		3.9		5.3		5.2
April		5.4		6.1		5.6
May		5.9		7.5		7.4
June		5.9		7.3		6.8
July		4.5		5.2		5.7
August		5.8		7.2		7.0
September		6.8		8.0		7.6
October	4.7		7.2		5.6	
November	3.5		4.4		3.9	
December	3.5		4.6		4.0	

TABLE 3.

PERCENT OF TIME VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE EQUALS 6 MILES OR MORE ON CUMBERLAND NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 6,682 observations

Month	9:00 A. M.		12:00 noon		4:00 P. M.	
	1936	1937	1936	1937	1936	1937
January		44.1		60.2		45.8
February		55.1		67.3		64.6
March		38.6		62.1		61.5
April		61.7		71.1		64.4
May		69.0		85.8		83.4
June		68.6		82.0		80.9
July		50.0		59.6		65.4
August		67.2		83.8		80.7
September		80.6		94.8		87.0
October	54.5		78.5		65.4	
November	31.3		50.2		41.0	
December	33.8		47.7		41.3	

TABLE 4.

PERCENT OF TIME STANDARD SMOKE IS VISIBLE ON THE CUMBERLAND NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	All months
	Percent of time visible												
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	87.1	95.9	91.7	97.3	97.4	97.8	95.6	97.5	98.1	90.1	85.2	87.1	93.3
3	67.2	78.8	70.2	82.7	91.2	89.6	73.0	90.4	94.0	80.1	63.0	64.9	78.5
4	51.4	62.6	50.9	67.6	80.5	77.7	59.2	78.1	86.1	68.9	41.9	42.5	63.4
5	29.9	54.1	33.0	46.9	59.8	57.6	26.9	58.6	69.2	52.8	25.5	21.8	43.0
6	15.8	22.5	12.3	28.8	38.9	36.2	10.1	39.2	50.2	32.1	12.5	9.7	25.4
7	7.0	10.6	4.8	14.2	16.9	17.3		19.2	30.0	18.6	5.7	4.2	12.4
8	1.7	4.2	2.1	6.4	4.6	7.5		8.3	13.2	6.9	2.4	2.3	4.9
9	0.2	0.6	0.6	3.4	1.1	1.7		3.3	3.7	1.3	1.1	0.9	1.6
10				1.3	0.1	0.6		0.2	1.0	0.9	0.1	0.1	0.4
11				0.1	0.1					0.4		0.1	0.1
12					0.1					0.4		0.1	0.04
Visibility Distance: 70% of time, miles	2.9	3.5	3.0	3.8	4.5	4.4	3.2	4.4	5.0	3.9	2.7	2.8	3.6
Basis, number of observations	553	616	665	703	700	468	159	568	509	231	806	687	6665

TABLE 5.

VISIBILITY DISTANCE OF STANDARD SMOKE ON CUMBERLAND NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 6,665 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.		12:00 noon		4:00 P. M.	
	1936	1937	1936	1937	1936	1937
January		2.9		3.4		2.8
February		3.2		3.9		3.7
March		2.8		3.2		3.5
April		3.7		4.1		3.8
May		4.0		4.8		4.8
June		4.1		4.6		4.5
July		2.9		3.3		3.6
August		4.0		4.8		4.6
September		4.5		5.5		5.1
October	3.2		4.6		3.9	
November	2.4		2.9		2.8	
December	2.5		3.2		2.7	

TABLE 6.

PERCENT OF TIME VISIBILITY DISTANCE OF STANDARD SMOKE EQUALS 6 MILES OR MORE ON CUMBERLAND NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 6,665 observations

Month	9:00 A. M.		12:00 noon		4:00 P. M.	
	1936	1937	1936	1937	1936	1937
January		12.5		20.6		16.0
February		22.1		20.1		25.8
March		5.0		16.1		15.0
April		22.8		34.8		28.8
May		25.5		45.1		46.2
June		25.2		43.1		40.4
July		1.8		15.1		13.5
August		25.7		51.6		40.3
September		38.3		60.8		53.2
October	17.8		41.2		35.9	
November	6.6		17.4		13.6	
December	6.0		12.7		10.7	

TABLE 7.

PERCENT OF TIME EIGHTH-ACRE SMOKE IS VISIBLE ON THE GEORGE WASHINGTON NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: March	April	May		Oct.	Nov.	All months
	Percent of time visible						
1	100.0	100.0	100.0		100.0	100.0	100.0
2	99.8	100.0	100.0		99.9	100.0	99.9
3	99.0	99.2	100.0		99.7	98.9	99.3
4	97.1	97.3	97.3		98.6	96.8	97.3
5	94.6	95.6	97.0		97.5	93.8	95.4
6	88.8	90.4	93.2		93.3	86.5	89.8
7	81.5	81.3	89.1		86.4	76.6	81.8
8	66.3	67.5	78.8		74.4	65.1	69.4
9	50.9	52.3	67.8		60.4	53.5	56.2
10	39.5	39.2	53.6		46.8	41.7	43.6
11	29.7	31.8	42.1		37.2	34.9	35.0
12	22.3	23.4	32.5		29.5	26.3	26.6
13	11.9	15.1	21.2		21.4	18.2	17.6
14	9.3	12.0	15.7		17.7	15.3	14.1
15	5.7	8.5	11.9		14.0	11.8	10.5
16	4.0	5.0	8.5		9.4	7.4	6.8
17	2.9	3.6	7.2		7.1	4.9	5.0
18	2.6	2.8	5.9		4.4	3.9	3.9
19	1.9	2.2	4.8		2.7	2.7	2.8
20	1.9	1.2	3.2		1.3	1.4	1.7
21	1.4	0.7	1.6		0.7	0.5	0.9
22	1.4	0.7	1.3		0.5	0.5	0.8
23	0.5	0.5	1.1		0.5	0.3	0.5
24	0.2	0.3	0.6		0.5	0.3	0.3
25		0.1	0.3		0.5	0.1	0.2
26			0.3		0.2	0.1	0.1
27					0.2		0.02
Visibility Distance: 70% of time, miles	7.7	7.8	8.8		8.3	7.6	8.0
Basis, number of observations	579	961	707		594	1397	4238

TABLE 8.

VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE ON GEORGE WASHINGTON NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 4,238 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
March		7.4	7.3		8.0	8.0		7.6	8.6
April		7.7	7.5		7.8	8.1		7.9	7.9
May		8.0	8.9		8.5	10.3		8.1	10.1
October		7.9	7.5		8.4	8.3		8.1	8.3
November	7.1	8.5	6.6	7.6	8.6	7.3	7.5	8.1	6.3

TABLE 9.

PERCENT OF TIME VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE EQUALS 6 MILES OR MORE ON GEORGE WASHINGTON NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 4,238 observations

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
March		86.9	86.4		93.2	91.7		82.1	92.6
April		90.6	87.5		90.7	93.1		88.8	91.6
May		88.0	97.9		90.4	99.0		90.9	97.8
October		98.1	86.0		96.6	92.6		96.6	91.3
November	81.7	95.8	78.7	86.8	91.7	86.0	85.5	87.2	75.6

TABLE 10.

PERCENT OF TIME STANDARD SMOKE IS VISIBLE ON THE GEORGE WASHINGTON NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: March	April	May	October	Nov.	All months
	Percent of time visible					
1	100.0	100.0	100.0	100.0	100.0	100.0
2	99.4	100.0	100.0	99.8	99.2	99.6
3	94.1	96.8	97.0	97.1	95.4	96.0
4	87.9	90.5	93.1	92.8	88.0	90.0
5	73.3	73.4	82.1	77.1	72.9	75.1
6	51.3	52.1	67.9	54.4	57.4	56.8
7	35.2	35.3	48.3	32.6	39.0	38.5
8	22.4	22.6	32.4	20.9	25.7	26.2
9	9.6	12.3	17.8	11.2	15.9	14.0
10	4.1	6.3	11.4	5.8	9.1	7.7
11	2.4	3.4	7.2	3.6	4.7	4.4
12	1.6	2.2	5.4	1.8	3.1	3.0
13	1.4	1.0	2.4	0.9	1.0	1.3
14	0.5	0.7	1.3	0.2	0.3	0.6
15	0.2	0.2	0.6	0.2	0.2	0.3
16				0.2	0.1	0.05
Visibility Distance: 70% of time, miles	5.2	5.2	5.9	5.3	5.2	5.3
Basis, number of observations	580	945	709	445	1445	4,124

TABLE 11.

VISIBILITY DISTANCE OF STANDARD SMOKE ON GEORGE WASHINGTON NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 4,124 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
March		4.9	4.7		5.2	5.5		4.9	5.9
April		5.0	4.9		5.2	5.4		5.2	5.3
May		5.1	6.0		5.5	6.8		5.4	6.8
October		5.3	4.8		5.5	5.5		5.3	5.5
November	4.7	6.0	4.4	5.0	6.2	4.8	4.9	6.0	4.3

TABLE 12.

PERCENT OF TIME VISIBILITY DISTANCE OF STANDARD SMOKE EQUALS 6 MILES OR MORE ON GEORGE WASHINGTON NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 4,124 observations

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
March		40.6	42.0		51.9	58.9		46.2	67.7
April		40.9	47.5		55.4	60.9		45.7	59.6
May		51.9	70.5		60.3	89.8		61.8	86.0
October		56.8	37.5		63.3	56.8		55.9	59.8
November	49.0	70.5	37.3	54.8	74.1	44.6	52.9	69.4	42.2

TABLE 13.

PERCENT OF TIME EIGHTH-ACRE SMOKE IS VISIBLE ON THE JEFFERSON NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	March	April	May		Oct.	Nov.	All months
	Percent of time visible						
1	100.0	100.0	100.0		100.0	100.0	100.0
2	100.0	100.0	100.0		100.0	100.0	100.0
3	99.6	100.0	100.0		100.0	99.6	99.8
4	98.5	100.0	99.7		99.1	97.0	98.6
5	98.1	99.8	99.7		97.8	95.4	97.8
6	91.8	97.6	98.5		94.7	92.2	94.8
7	87.3	93.6	95.5		90.4	88.3	91.0
8	74.6	88.9	91.6		79.0	79.1	82.8
9	62.3	74.2	80.3		69.7	68.6	71.1
10	53.0	60.9	64.5		55.2	57.6	58.5
11	45.1	47.8	55.8		46.3	48.6	48.7
12	33.2	31.9	37.0		34.9	37.0	35.0
13	19.4	15.9	21.2		17.9	23.8	20.0
14	14.9	12.7	16.7		11.4	19.3	15.6
15	9.3	9.7	11.0		8.6	14.1	11.1
16	3.0	2.4	5.7		4.9	4.1	3.9
17	1.9	0.8	4.8		2.8	2.6	2.4
18	1.5	0.6	3.6		1.5	2.3	1.9
19	0.7	0.2	3.3		0.9	1.0	1.1
20	0.7		1.8		0.3	0.6	0.6
21	0.7		0.9		0.3		0.3
22	0.7		0.6				0.2
23			0.3				0.05
24			0.3				0.05
Visibility Distance: 70% of time, miles	8.4	9.3	9.7		9.0	8.9	9.1
Basis, number of observations	268	504	335		324	694	2125

TABLE 14.

VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE ON JEFFERSON NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 2,125 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
April		8.2	9.7		9.4	10.1		8.5	10.0
May		9.2			9.9			9.7	
October	8.6			8.7			9.7		
November	7.6	10.3	9.9	7.5	10.3	10.1	8.1	8.9	10.2

TABLE 15.

PERCENT OF TIME VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE EQUALS 6 MILES OR MORE ON JEFFERSON NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 2,125 observations

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
April		96.3	97.4		96.4	100.0		95.6	100.0
May		96.8			98.0			100.0	
October	95.8			93.4			96.7		
November	88.3	94.6	92.7	82.3	98.8	98.3	86.9	97.4	98.2

TABLE 16.

PERCENT OF TIME STANDARD SMOKE IS VISIBLE ON THE JEFFERSON NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: April	May		October	November	All months
	Percent of time visible					
1	100.0	100.0		100.0	100.0	100.0
2	100.0	100.0		100.0	99.9	99.9
3	99.6	99.7		97.7	95.7	97.9
4	97.4	98.8		95.3	92.1	95.4
5	90.4	95.0		82.0	82.6	87.6
6	74.4	83.6		70.3	68.9	73.9
7	55.8	65.7		62.2	53.5	57.8
8	31.4	39.8		44.2	37.3	36.9
9	10.4	18.9		17.4	21.5	18.3
10	3.4	6.0		10.5	6.9	6.0
11	1.0	3.7		5.2	2.4	2.6
12	0.4	2.5		1.7	1.6	1.5
13		0.5		0.6	0.4	0.3
14					0.1	0.1
Visibility Distance: 70% of time, miles	6.2	6.8		6.0	5.9	6.2
Basis, number of observations	500	402		172	697	1771

TABLE 17.

VISIBILITY DISTANCE OF STANDARD SMOKE ON JEFFERSON NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 1,771 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
April		5.4	6.4		6.3	6.9		5.5	6.7
May		6.2			6.8			6.7	
October	5.7			5.7			6.6		
November	4.9	6.9	6.9	5.1	6.9	6.7	5.5	5.9	7.8

TABLE 18.

PERCENT OF TIME VISIBILITY DISTANCE OF STANDARD SMOKE EQUALS 6 MILES OR MORE ON JEFFERSON NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 1,771 observations

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
April		58.8	79.7		75.9	90.2		59.3	83.5
May		72.8			84.5			82.0	
October	66.7			66.1			77.4		
November	48.9	74.6	81.8	56.8	79.8	78.7	60.6	68.8	87.7

TABLE 19.

PERCENT OF TIME EIGHTH-ACRE SMOKE IS VISIBLE ON THE MONONGAHELA NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: March	April	May	June	July	August	Sept.	Oct.	Nov.	All months
	Percent of time visible									
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	100.0	99.9	100.0	99.8	100.0	99.5	100.0	99.8	98.7	99.6
3	100.0	98.7	99.5	98.8	98.3	95.7	100.0	98.6	94.3	97.7
4	97.6	95.7	96.5	92.6	96.1	88.9	98.1	95.0	88.4	93.6
5	97.0	93.0	94.3	90.2	93.0	81.7	97.1	90.1	84.1	90.1
6	89.9	85.6	90.0	80.0	85.6	70.2	93.7	78.1	74.0	81.4
7	76.9	76.8	81.8	69.3	70.0	53.4	90.8	63.0	61.7	70.0
8	57.4	60.7	69.3	53.1	53.0	41.3	85.4	46.5	48.7	55.5
9	42.0	45.4	58.5	36.7	38.7	38.5	72.3	35.6	37.9	43.4
10	30.8	31.1	45.3	20.1	27.0	28.8	61.2	25.8	28.6	31.7
11	23.1	23.9	35.6	13.1	17.0	20.2	49.0	19.0	23.6	24.3
12	14.2	15.2	23.7	3.6	11.3	17.3	24.3	13.3	18.1	16.1
13	10.1	9.2	13.6	2.1	3.0	5.8	10.2	8.5	13.1	9.8
14	5.3	7.7	10.6	1.2	1.7	3.8	7.3	6.5	10.6	7.6
15		4.8	7.1		1.3	2.4	3.4	4.1	7.4	4.8
16		2.1	3.4		0.9	1.0	1.5	2.2	4.7	2.6
17		1.4	1.3				1.0	1.2	2.6	1.3
18		1.1	1.1				0.5	0.6	1.1	0.8
19		0.1	0.8					0.4	0.4	0.3
20		0.1	0.7					0.3	0.2	0.2
21			0.5					0.1	0.1	0.1
22			0.3					0.1	0.1	0.1
23								0.1		0.02
24								0.1		0.02
Visibility Distance: 70% of time, miles	7.4	7.4	7.9	6.9	7.0	6.0	9.2	6.5	6.3	7.0
Basis, number of observations	169	1013	848	420	230	208	206	1108	1307	5509

TABLE 20.

VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE ON THE MONONGAHELA NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 5,509 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
March			6.8			7.8			7.3
April		6.1	7.3		7.0	8.0		6.5	7.9
May		7.4	8.6		8.0	9.2		7.4	9.2
June		6.4			7.2			7.1	
July		6.5			7.6			6.9	
August		5.9			6.3			5.5	
September		8.4			9.6			9.2	
October	6.1	6.7	6.1	7.0	6.4	6.8	7.1	6.2	6.5
November	4.3	6.6	7.1	5.0	6.9	8.1	4.7	6.2	7.4

TABLE 21.

PERCENT OF TIME VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE EQUALS 6 MILES OR MORE ON THE MONONGAHELA NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 5,509 observations

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
March			85.7			94.7			88.9
April		70.6	89.8		77.6	94.4		74.6	93.0
May		83.0	96.9		91.8	97.9		84.2	95.8
June		74.4			85.6			79.7	
July		77.0			92.5			86.8	
August		67.7			76.7			65.8	
September		91.4			90.5			96.8	
October	71.3	82.4	71.4	79.8	75.0	84.5	86.3	74.0	76.9
November	54.7	80.3	79.3	59.7	84.7	88.4	57.3	73.2	89.2

TABLE 22.

PERCENT OF TIME STANDARD SMOKE IS VISIBLE ON THE MONONGAHELA NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: March	April	May	June	July	August	Sept.	Oct.	Nov.	All months
	Percent of time visible									
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	100.0	99.2	100.0	98.8	99.6	96.1	100.0	98.4	95.8	98.3
3	97.6	94.4	95.0	92.0	96.1	84.1	97.3	90.8	86.4	91.5
4	89.9	86.0	89.6	81.4	86.5	71.0	92.9	78.1	74.0	81.6
5	66.8	67.8	75.4	62.8	63.5	45.4	86.4	51.6	53.4	61.4
6	44.4	46.3	59.6	37.9	39.1	38.2	70.6	35.7	38.1	43.7
7	31.3	27.7	43.9	18.4	24.8	26.1	54.4	22.6	26.7	29.0
8	15.4	15.7	26.1	3.9	11.3	16.9	28.2	13.2	18.0	16.7
9	7.1	8.5	12.7	2.2	1.7	3.9	9.2	7.4	11.9	8.8
10		3.6	4.9		0.9	1.4	1.1	3.2	5.8	3.6
11		1.4	1.1				0.5	1.2	2.6	1.3
12		1.0	0.7					0.5	0.6	0.5
13		0.1						0.2	0.2	0.1
14								0.1		0.02
Visibility Distance: 70% of time, miles	4.9	4.9	5.3	4.6	4.7	4.0	6.0	4.3	4.2	4.6
Basis, number of observations	169	1014	834	414	230	207	184	1115	1298	5,465

TABLE 23.

VISIBILITY DISTANCE OF STANDARD SMOKE ON THE MONONGAHELA NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 5,465 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
March			4.5			5.4			4.7
April		4.0	4.8		4.4	5.4		4.5	5.2
May		4.9	5.8		5.3	6.3		4.9	6.4
June		4.4			4.7			4.6	
July		4.4			5.0			4.7	
August		3.9			4.2			4.0	
September		5.5			6.7			6.2	
October	4.1	4.4	4.1	4.6	4.1	4.5	4.7	4.1	4.3
November	3.0	4.4	4.6	3.4	4.6	5.2	2.9	4.2	4.8

TABLE 24.

PERCENT OF TIME VISIBILITY DISTANCE OF STANDARD SMOKE EQUALS 6 MILES OR MORE ON THE MONONGAHELA NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 5,465 observations

Month	9:00 A. M.			12:00 noon			4:00 P. M.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
March			32.6			53.4			45.2
April		36.4	39.8		48.0	56.6		43.2	48.4
May		49.1	67.0		59.4	74.5		48.9	76.8
June		29.9			44.3			38.8	
July		28.8			43.8			44.2	
August		38.7			38.4			37.5	
September		57.9			76.5			76.2	
October	33.0	32.9	30.6	45.9	33.8	35.5	46.1	35.1	33.6
November	26.3	35.3	46.4	29.6	44.0	56.1	26.8	34.3	43.2

TABLE 25.

PERCENT OF TIME EIGHTH-ACRE SMOKE IS VISIBLE ON THE WHITE MOUNTAIN NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: May	June	July	August	Sept.	Oct.	Nov.	All months
	Percent of time visible							
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9
3	99.2	100.0	100.0	99.8	100.0	100.0	100.0	99.9
4	98.8	99.4	98.6	98.4	99.7	99.3	99.5	99.1
5	97.9	99.0	96.8	97.0	99.5	98.6	99.5	98.3
6	96.7	97.3	93.4	92.3	95.0	97.6	98.9	95.6
7	95.9	95.8	90.8	86.7	91.7	95.2	96.8	92.8
8	92.2	92.0	85.0	77.6	83.6	90.8	91.6	86.9
9	84.8	88.0	75.4	66.1	73.0	80.9	88.9	78.8
10	78.7	82.9	69.1	61.0	68.8	74.1	87.4	73.6
11	74.6	80.2	62.1	57.0	66.5	69.6	85.8	69.9
12	71.7	76.6	55.2	51.9	62.0	62.4	82.1	65.0
13	55.3	69.2	43.1	37.8	51.6	47.1	70.0	53.0
14	50.4	66.2	37.3	31.1	47.6	44.0	65.8	48.5
15	43.8	61.0	28.9	26.6	39.8	33.1	56.8	41.5
16	34.4	50.6	21.7	21.0	35.0	27.0	49.5	34.1
17	27.9	40.9	15.6	14.0	29.0	24.6	39.5	27.2
18	19.7	31.6	8.7	8.9	24.4	20.1	30.5	20.5
19	17.6	26.4	6.6	6.8	18.4	19.1	25.8	17.0
20	15.2	20.2	4.3	5.1	15.9	16.0	17.9	13.4
21	5.7	11.0	2.6	3.3	13.4	15.7	13.7	9.1
22	5.3	5.7	1.7	3.0	12.3	14.0	11.0	7.1
23	4.9	3.8	0.6	2.1	3.8	10.2	10.0	4.4
24	4.5	2.5		1.4	2.3	2.0	6.3	2.3
25		1.9		0.7	2.3	1.7	5.3	1.5
26		0.6		0.5	2.3	1.7	3.2	1.0
27		0.2		0.2	1.5		1.6	0.4
28					0.5		1.0	0.2
29							0.5	0.1
Visibility Distance: 70% of time, Miles:	12.1	12.9	9.9	8.7	9.7	10.9	13.0	11.0
Basis, number of observations	244	526	346	428	397	293	190	2,424

TABLE 26.

VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE ON THE WHITE MOUNTAIN NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 2,424 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.		12:00 noon		4:00 P. M.	
	1937	1938	1937	1938	1937	1938
June	12.6	12.3	14.4	14.1	12.1	14.0
July	9.7		10.1		9.7	
August	8.2		8.6		9.3	
September	9.1		10.1		10.1	
October	11.0		11.5		10.1	

TABLE 27.

PERCENT OF TIME VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKE EQUALS 6 MILES OR MORE ON THE WHITE MOUNTAIN NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 2,424 observations

Month	9:00 A. M.		12:00 noon		4:00 P. M.	
	1937	1938	1937	1938	1937	1938
June	97.8	94.9	96.8	96.5	100.0	97.6
July	94.4		94.8		91.0	
August	91.9		89.9		95.1	
September	93.2		96.9		94.8	
October	96.8		100.0		96.0	

TABLE 28.

PERCENT OF TIME STANDARD SMOKE IS VISIBLE ON THE WHITE MOUNTAIN NATIONAL FOREST, BY MONTHS

Visibility Distance: miles	Month: June	July	August	September	October	All months
	Percent of time visible					
1	100.0	100.0	100.0	100.0	100.0	100.0
2	99.8	99.6	99.5	100.0	100.0	99.8
3	99.2	96.4	97.4	99.3	99.0	98.4
4	96.8	92.1	91.6	94.6	97.9	94.6
5	92.5	85.7	80.1	85.6	93.1	87.4
6	87.5	73.7	66.3	72.1	81.3	76.6
7	81.2	65.7	60.2	66.6	73.4	70.0
8	76.3	54.2	52.2	61.5	63.7	62.4
9	66.5	37.7	33.5	49.4	47.4	48.2
10	56.3	24.6	24.4	37.6	31.1	36.6
11	40.4	13.1	14.1	28.6	26.0	26.0
12	28.4	7.0	7.7	20.0	21.1	17.5
13	16.5	2.8	3.5	13.8	16.3	10.7
14	4.7	1.7	2,3	11.0	10.7	5.8
15	2.2		1.9	8.8		2.7
16	0.6		0.7	2.2		0.7
17				1.0		0.2
Visibility Distance: 70% of time, miles	8.6	6.5	5.7	6.4	7.3	7.0
Basis, number of observations	535	358	427	399	289	2,008

TABLE 29.

VISIBILITY DISTANCE OF STANDARD SMOKE ON THE WHITE MOUNTAIN NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 2,008 observations

Visibility in Miles 70% of Time

Month	9:00 A. M.		12:00 noon		4:00 P. M.	
	1937	1938	1937	1938	1937	1938
June	8.9	8.0	9.0	9.0	8.0	9.1
July	6.6		6.7		6.1	
August	5.4		5.7		6.2	
September	6.0		6.3		6.8	
October	7.8		7.6		7.0	

TABLE 30.

PERCENT OF TIME VISIBILITY DISTANCE OF STANDARD SMOKE EQUALS 6 MILES OR MORE ON THE WHITE MOUNTAIN NATIONAL FOREST, BY MONTHS AND HOURS OF DAY

Basis: 2,008 observations

Month	9:00 A. M.		12:00 noon		4:00 P. M.	
	1937	1938	1937	1938	1937	1938
June	91.0	82.7	88.8	88.2	86.7	86.9
July	73.9		76.7		70.8	
August	61.3		66.0		71.3	
September	69.7		71.4		75.4	
October	82.8		81.6		79.6	

FIGURE 1

VISIBILITY DISTANCES OF STANDARD AND EIGHTH-ACRE SMOKE COLUMNS

White Mountain National Forest, New Hampshire

Basis: 2216 observations

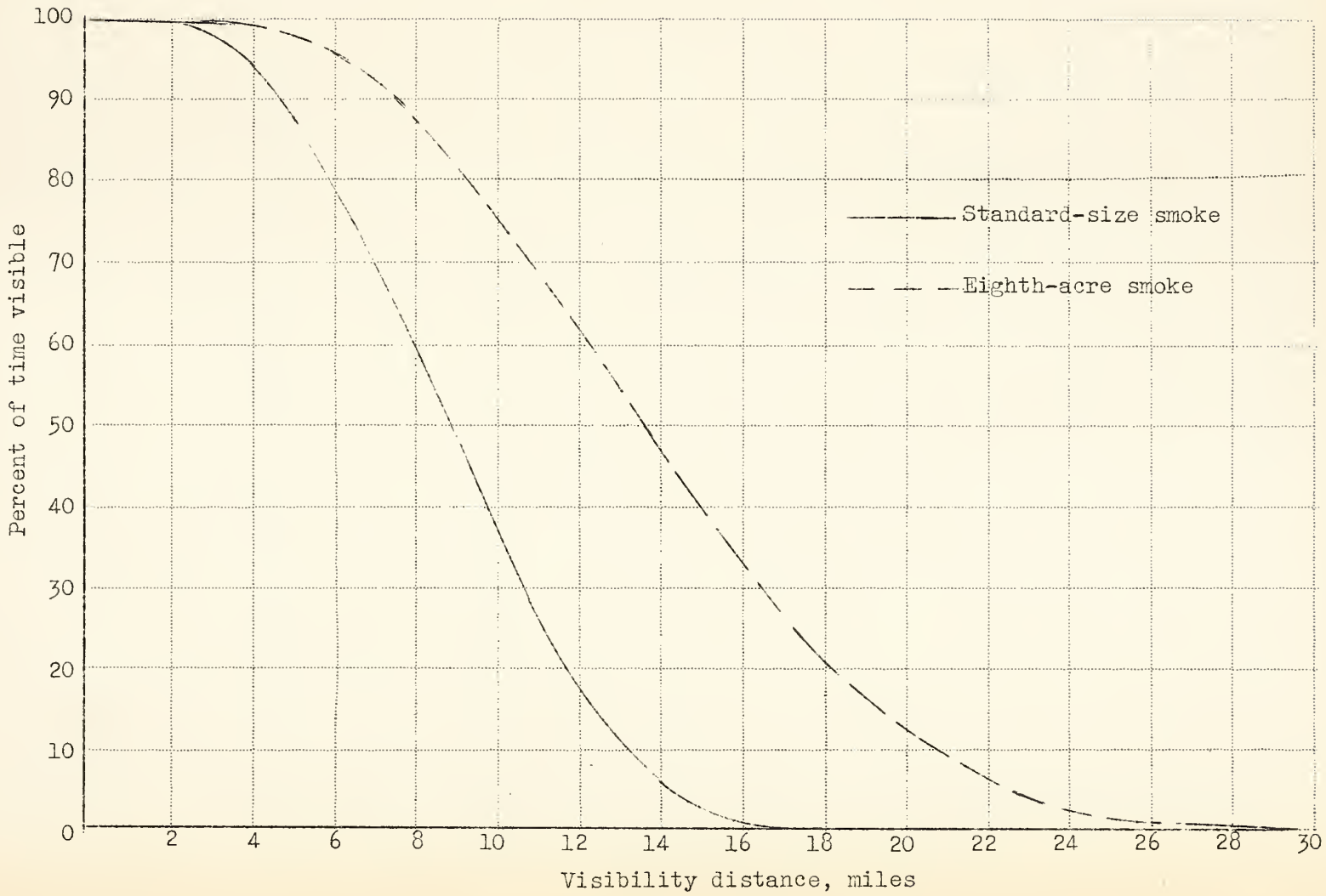

FIGURE 2

VISIBILITY DISTANCE OF STANDARD AND EIGHTH-ACRE SMOKE COLUMNS

Jefferson National Forest, Virginia

Basis: 6673 observations

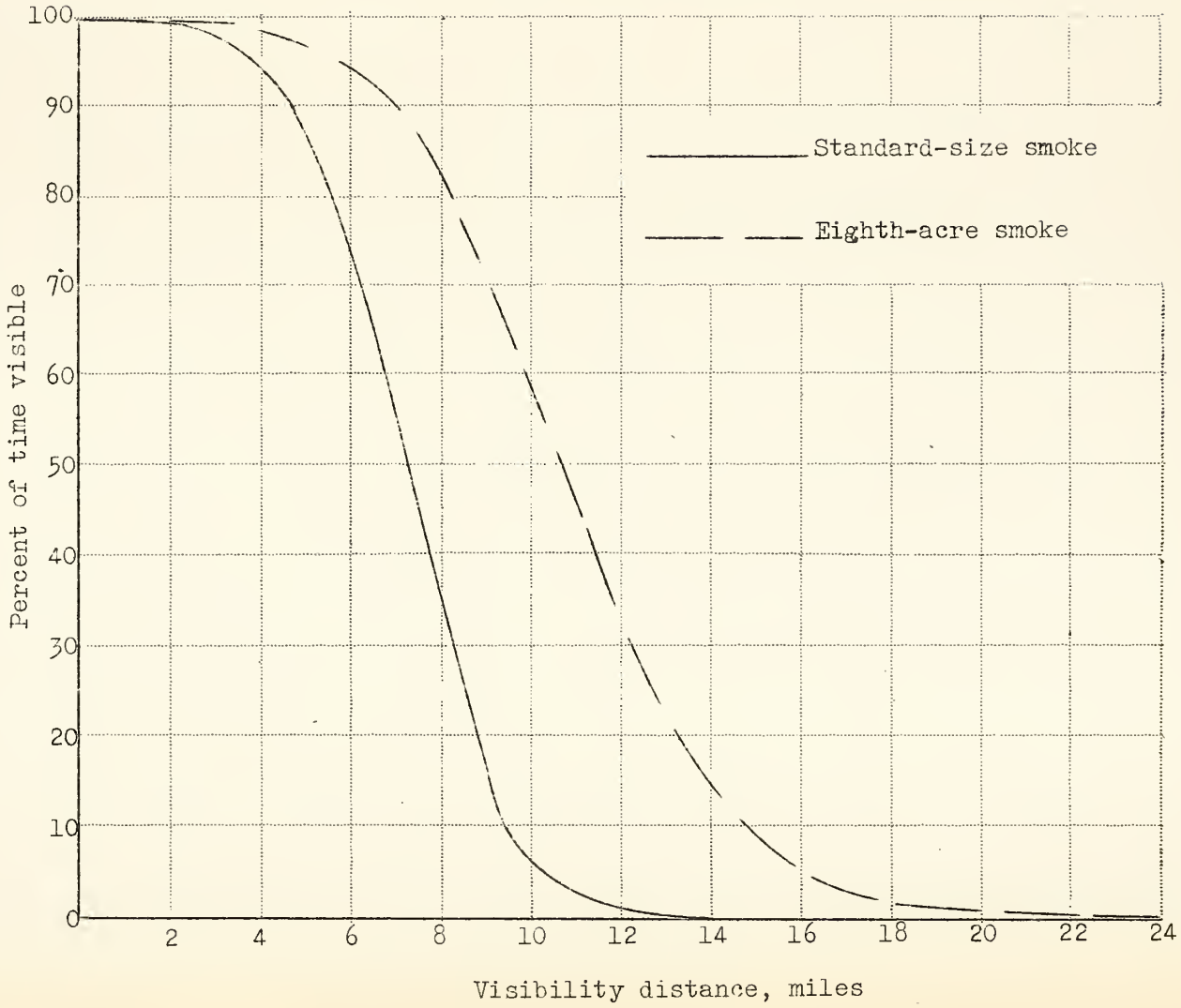

FIGURE 5

VISIBILITY DISTANCES OF STANDARD AND EIGHTH-ACRE SMOKE COLUMNS

George Washington National Forest, Virginia

Basis: 4181 observations

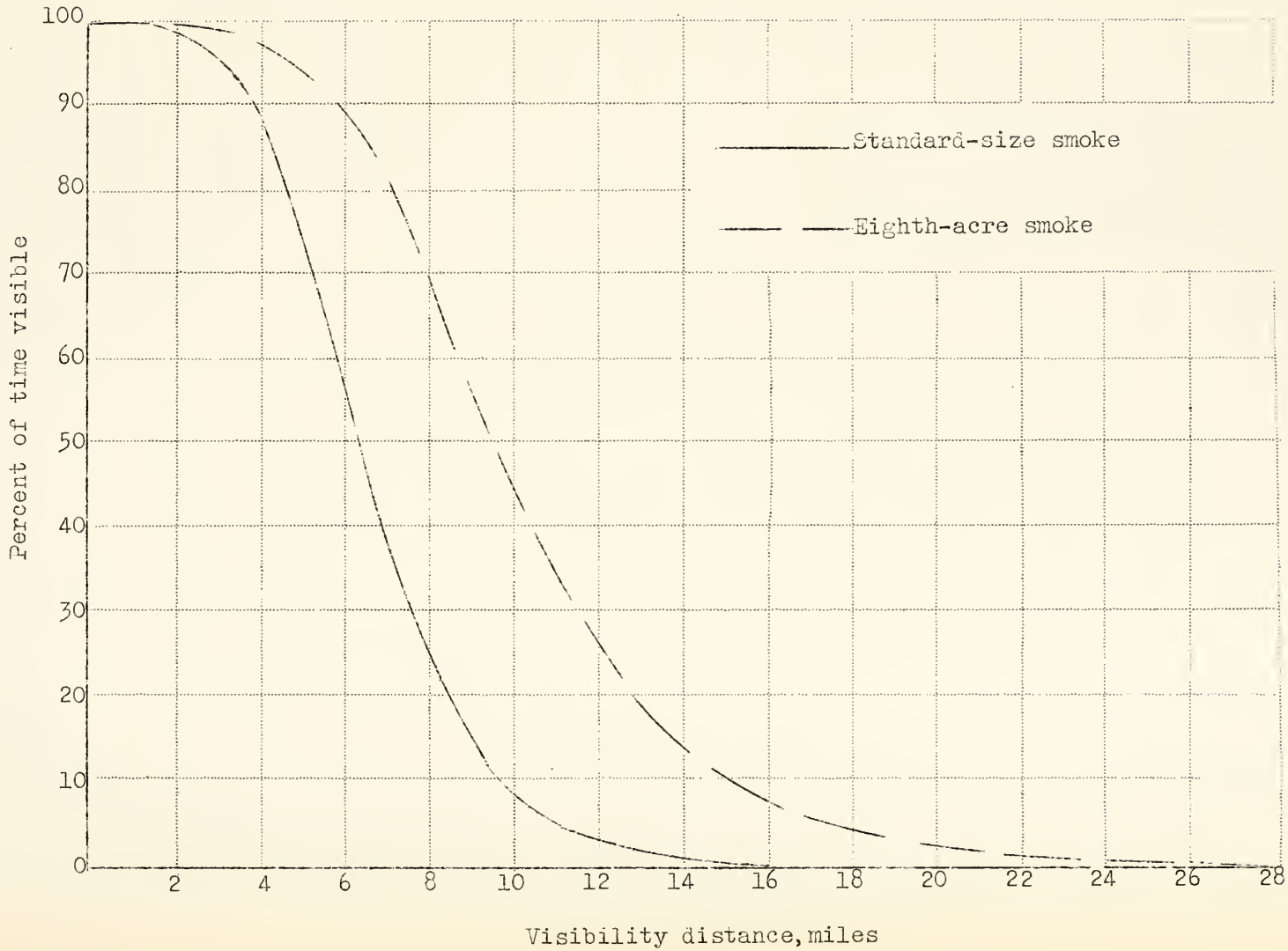

FIGURE 4

VISIBILITY DISTANCES OF STANDARD AND EIGHTH-ACRE SMOKE COLUMNS

Monongahela National Forest, West Virginia

Basis: 5487 observations

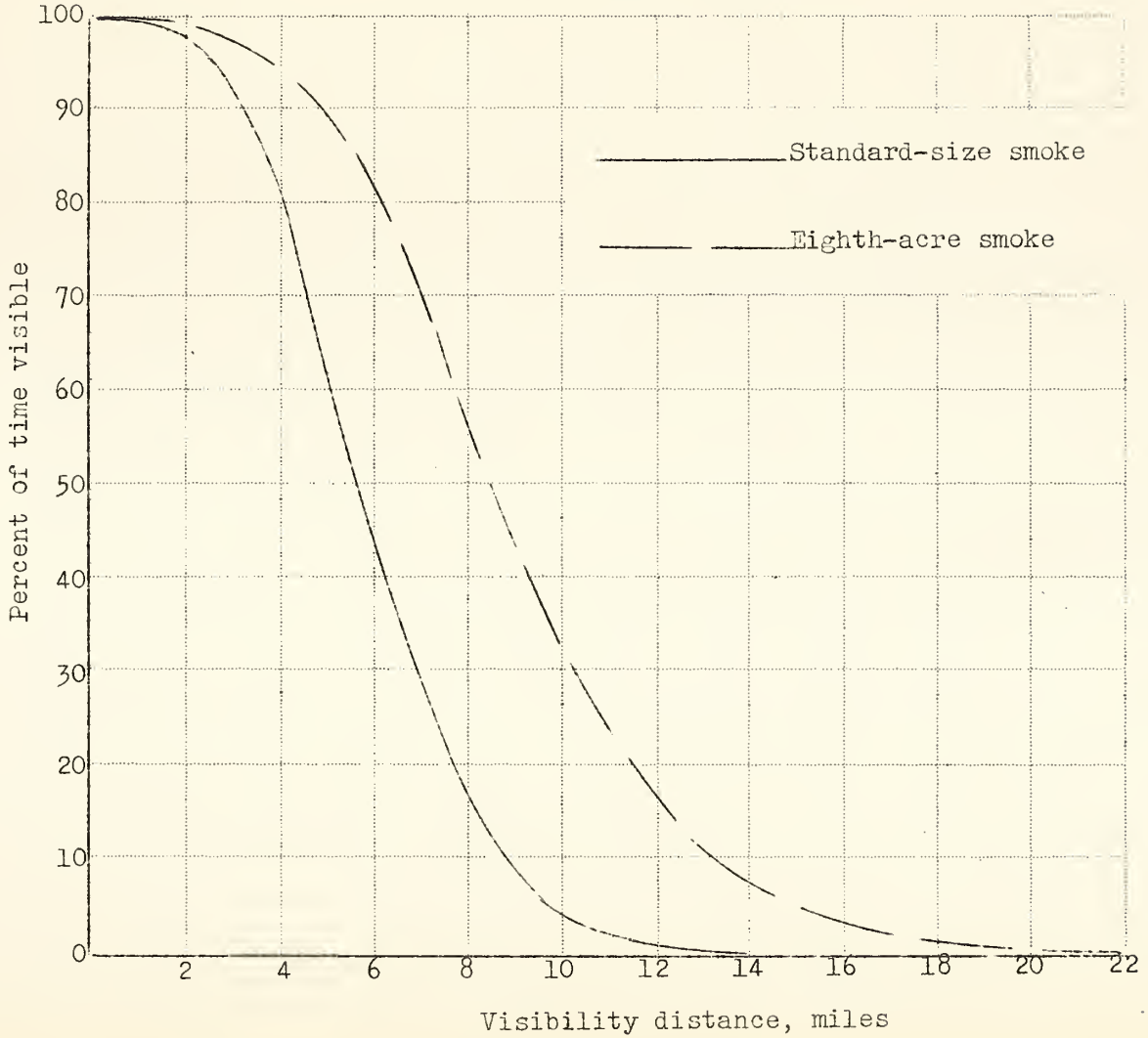

FIGURE 5

VISIBILITY DISTANCES OF STANDARD AND EIGHTH-ACRE SMOKE COLUMNS

Cumberland National Forest, Kentucky

Basis: 6673 observations

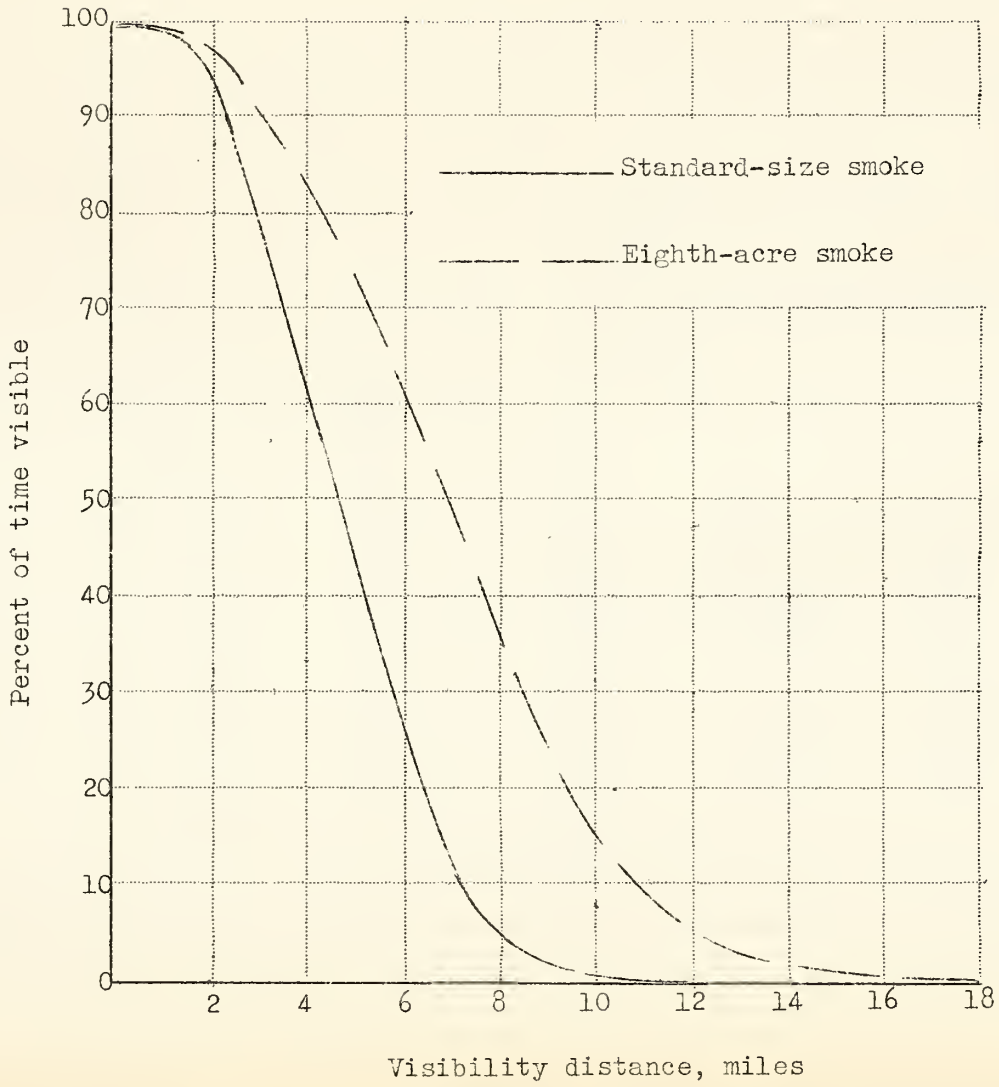

FIGURE 6

VISIBILITY DISTANCE 70 PERCENT OF TIME ON FIVE NATIONAL FORESTS

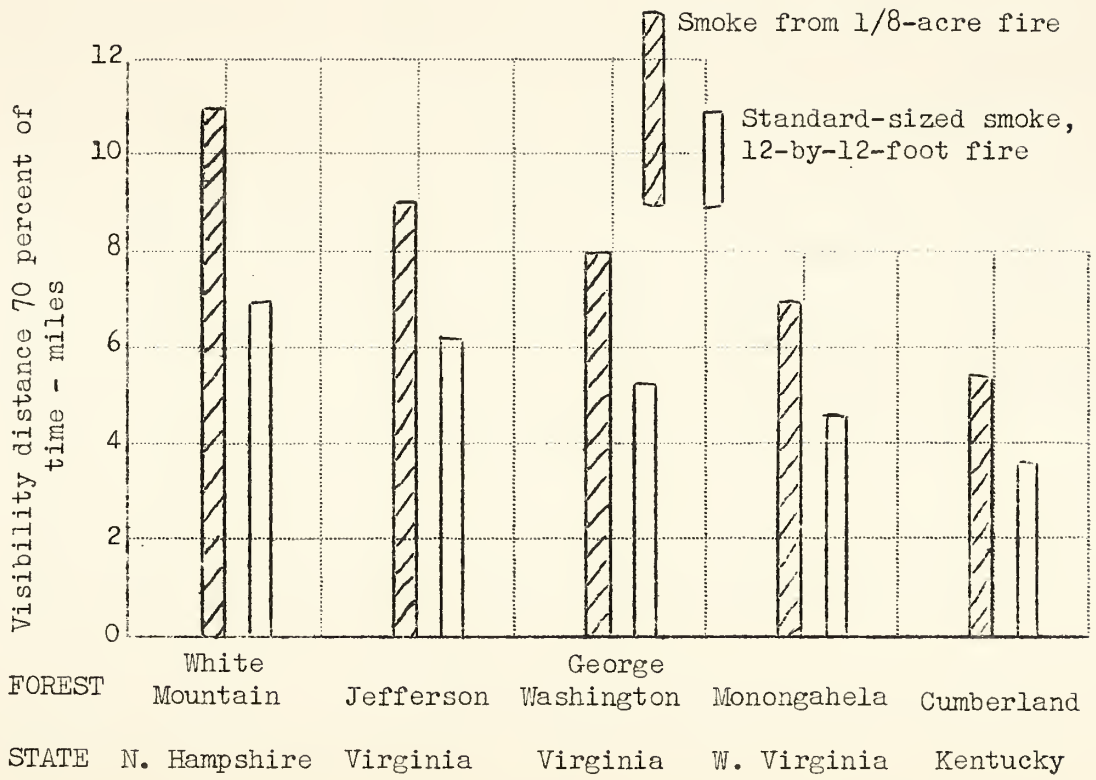

FIGURE 7

VISIBILITY DISTANCE 70 PERCENT OF THE TIME, BY MONTHS, FOR FIVE EASTERN NATIONAL FORESTS

Eighth-acre smokes

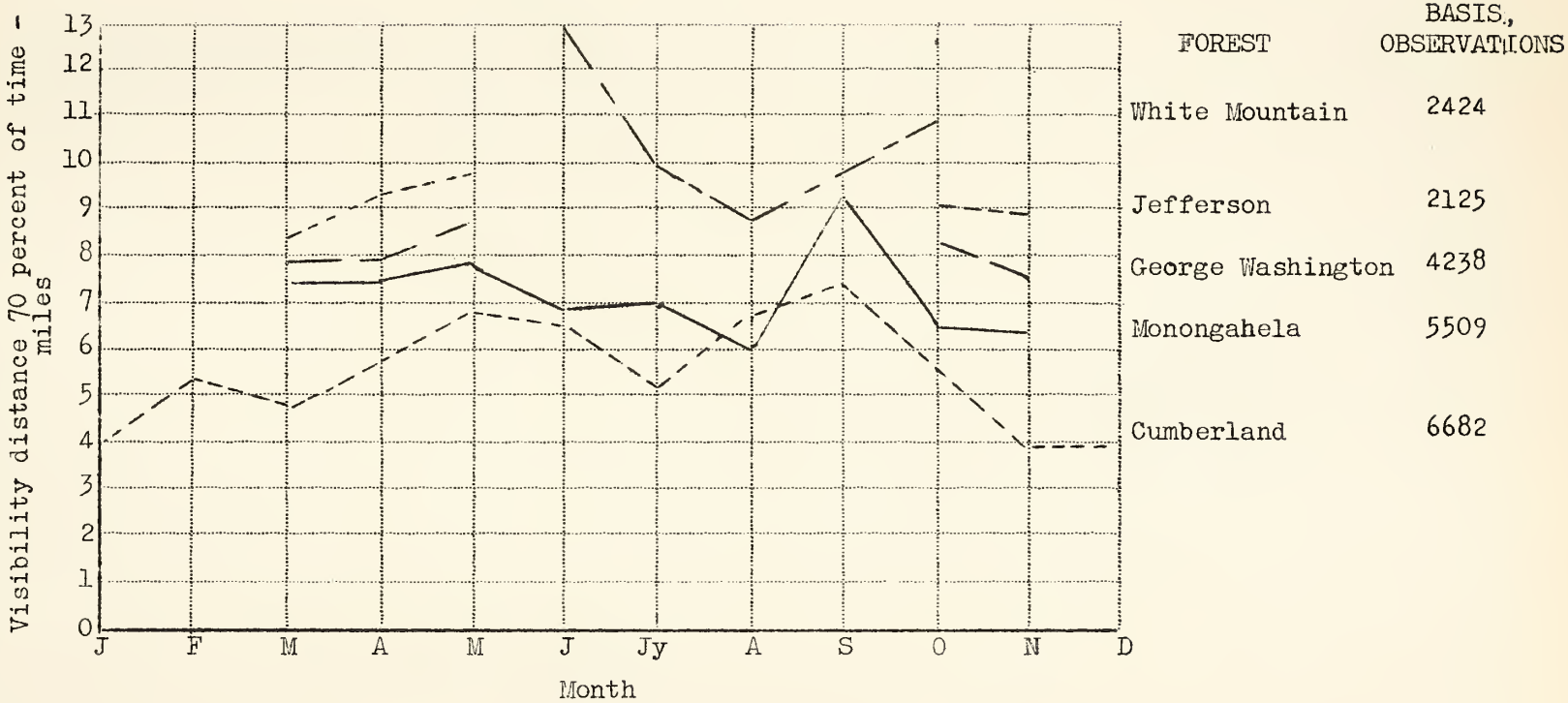

FIGURE 8

VISIBILITY DISTANCE 70 PERCENT OF THE TIME, BY MONTHS, FOR FIVE EASTERN NATIONAL FORESTS

Standard smokes

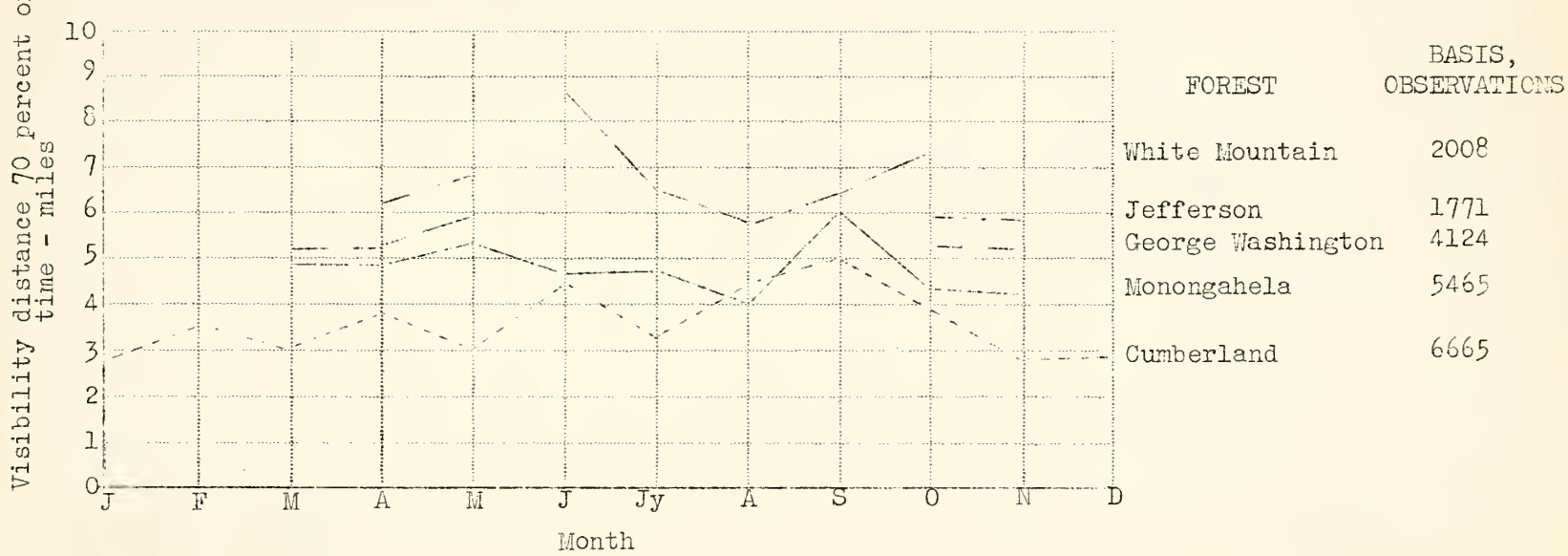

FIGURE 9

DIFFERENCES IN VISIBILITY DISTANCE OF EIGHTH-ACRE SMOKES BY HOURS OF THE DAY THROUGHOUT THE YEAR

Cumberland National Forest, Kentucky

Basis: 6682 observations

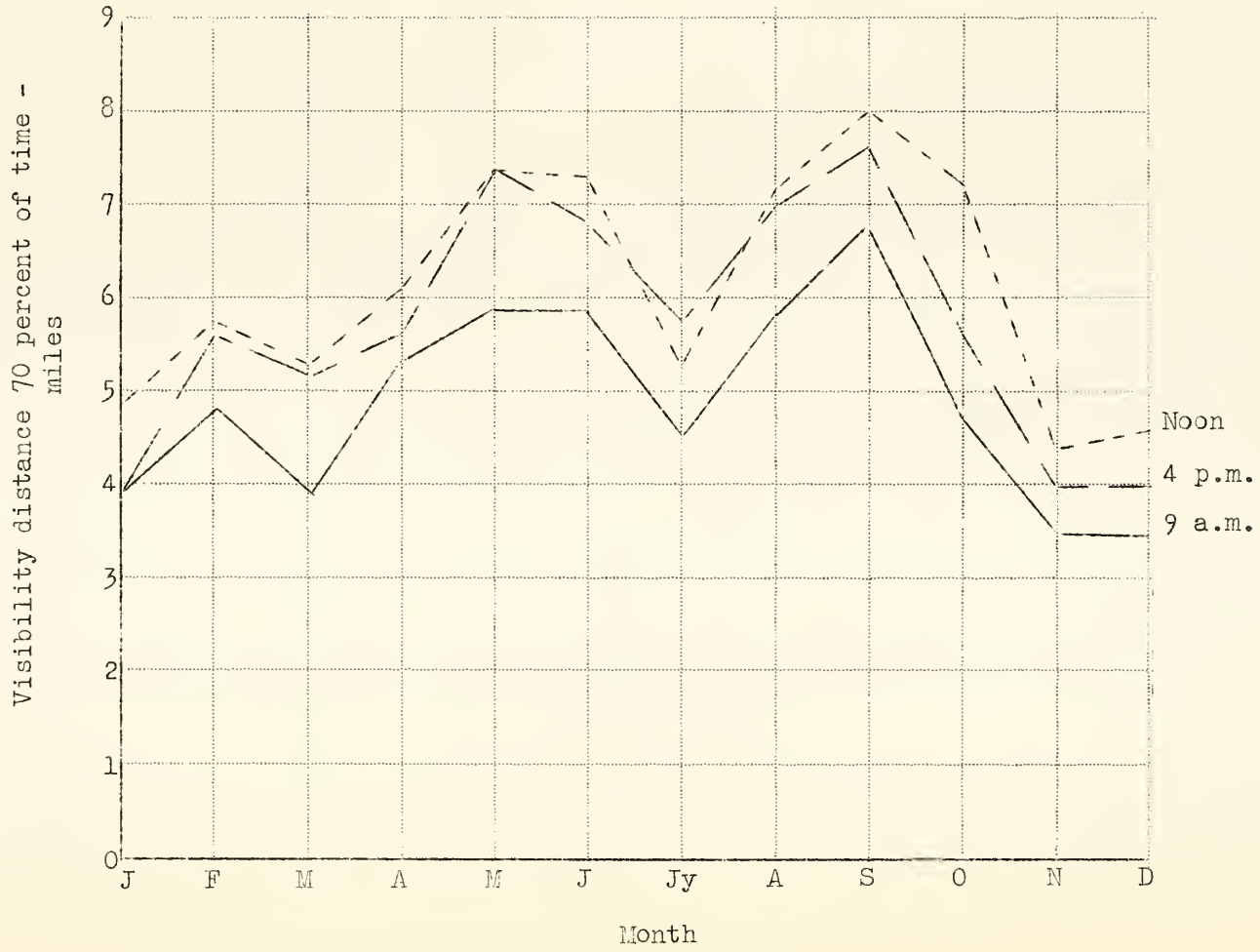

FIGURE 10

DIFFERENCES IN VISIBILITY DISTANCE OF STANDARD SMOKES BY HOURS OF THE DAY THROUGHOUT THE YEAR

Cumberland National Forest - Kentucky

Basis: 6665 observations